

## **LEPA AND SPRAY IRRIGATION IN THE SOUTHERN HIGH PLAINS**

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### **Abstract**

LEPA bubble and double-ended sock sprinkler methods were compared with in-canopy and overhead spray irrigation for corn, grain sorghum and wheat in the Southern High Plains. Irrigation treatments ranged from non-irrigated to fully-irrigated in three or four equal percentage increments. The fully-irrigated application amounts were scheduled from soil water contents determined by the neutron method. With equal deficit irrigation, grain yields with the LEPA methods tended to be larger than yields with the spray methods. With full irrigation, grain yields from the LEPA and spray methods were similar unless runoff with the LEPA method reduced yields.

### **Introduction**

In the Southern High Plains, spray heads have replaced impact sprinklers as the primary application device for center pivot irrigation systems. Improved application efficiency and reduced pumping pressure are the primary advantages of spray heads over impact sprinklers (Musick et al., 1988). Improved application efficiency is achieved by lowering the discharge point from the pipeline to nearer the crop thus reducing wind drift and droplet evaporation and by reducing the area wetted by the spray pattern. This concentration of applied water can cause runoff to be a more serious problem, however. In addition, spray uniformity can be reduced when spray heads are spaced too widely or placed within a crop canopy.

LEPA irrigation was introduced by Lyle and Bordovsky (1981) to further increase the application efficiency and decrease the pressure requirement of sprinkler irrigation. Applying water directly into alternate furrows eliminates water losses in the air and from the wetted crop canopy and reduces soil evaporation. Application efficiency in the 95-98% range is attainable (Lyle and Bordovsky, 1981, 1983). Uniformity coefficients generally exceed 0.95, and operating pressures can be 138 kPa or less at the center pivot point if land slope is small. Since LEPA is a complete irrigation system rather than just an appli-

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cation device, good management is required to obtain full benefits of the LEPA concept. In addition, the LEPA concept includes enhanced retention of rainfall by using appropriate tillage and crop residue management.

LEPA and spray irrigation are used extensively, but the two methods have not been compared directly for a variety of crops (Lyle and Bordovsky, 1983; Fipps and New, 1990). In the research reported here, LEPA bubble and LEPA double-ended sock sprinkler methods were compared with in-canopy and overhead spray irrigation for corn, grain sorghum and wheat in the Southern High Plains.

### **Procedure**

**Experimental Site.** The research was conducted on a 120-m wide by 660-m long field divided into four 165-m long experimental blocks at the USDA Conservation and Production Research Laboratory, Bushland, TX (35°11' N lat., 102°06' W long., 1170 m msl elevation). The soil is Pullman clay loam, a fine, mixed thermic, torrertic Paulestoll, and the field slope is a uniform 0.3%.

**Experimental Design.** The LEPA and spray sprinkler methods were evaluated with an irrigation control treatment receiving 100% of soil water replenishment and three or four deficit irrigation treatments that received a percentage of the control treatment application on the same date. Field plots were arranged in a randomized block experimental design with irrigation amounts being the blocks and sprinkler methods being randomized within each of three replicates.

The two LEPA sprinkler methods were bubble applicators and double-ended socks (Fangmeier et al, 1990; New and Fipps, 1990), and the two spray methods were in-canopy spray and overhead spray. LEPA bubble applicators were positioned about 0.3 m above ground level, and LEPA double-ended socks were drug in alternate crop furrows. Above canopy spray heads were located 1.75-m above ground, and in-canopy spray heads were positioned about 0.3 m above ground.

To schedule irrigations, soil water was measured weekly with a neutron probe in the three plots being fully irrigated with LEPA double-ended socks. Then, irrigations were applied to maintain plant available soil water above 90% in the 1.5-m profile for corn, above 75% in the 1.4-m profile for grain sorghum and above 70% in the 1.0-m profile for wheat.

**Irrigation Equipment.** Irrigations were applied with a hose-fed, Valmont<sup>2</sup> Model 6000 lateral move irrigation system equipped with a computerized CAMS control panel. The system had three, 39-m long spans providing space for forty eight, 0.76-m wide beds and furrows under each span. All application devices were spaced 1.52 m apart in alternate furrows and discharged 19.0 L/min. Pressure to the application devices was 207 kPa, but the LEPA bubble and in-canopy spray applicators were equipped with 41-kPa

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<sup>2</sup>The mention of trade or manufacturer names is made for information only and does not imply an endorsement, recommendation or exclusion by the USDA-Agricultural Research Service. Mention of a pesticide does not constitute a recommendation for use nor does it imply registration under FIFRA as amended.

pressure regulators. Senninger<sup>2</sup> 360° spray nozzles were placed above the LEPA socks to meter the flow at the same rate as the other devices.

**Cultural Practices.** Conventional cultural practices for irrigated grain production in the Southern High Plains were used. Crop residues were shredded as necessary, and tandem disking was used for primary tillage. For corn and grain sorghum, 0.76-m spaced beds were formed with a disk bedder, and furrows were diked before the first growing season irrigation. Wheat was flat planted in 0.25-m spaced rows, with no reservoir tillage to retain runoff.

Nitrogen fertilizer as anhydrous ammonia was applied at rates of 168 kg(N)/ha for corn, 112 kg(N)/ha for sorghum and 100 kg(N)/ha for wheat. A uniform 112 kg(P)/ha phosphorus application was made for all crops during the fall of 1991. Atrazine<sup>2</sup> was applied for broadleaf weed control in the corn and sorghum, and a mixture of Capture<sup>2</sup> and dimethoate<sup>2</sup> was applied for corn borer control.

## Results

**Grain Yields.** Rainfall was above average and favorably distributed for the 1992 grain sorghum, and the full irrigation treatments required only 250 mm of irrigation. With deficit irrigation, grain yields were larger with the LEPA methods than the spray methods, especially with the 50% irrigation amount, Figure 1. With 75% irrigation, the difference between LEPA and spray was smaller, and with full irrigation yields for the two sprinkler methods were essentially equal. When averaged across irrigation amounts, the two LEPA methods produced significantly larger yields ( $p=0.05$ ) than the two spray methods. Grain sorghum yield data were similar in 1993, but are not presented here because of space limitations (Schneider and Howell, 1993).

For the 1994 wheat yields illustrated in Figure 2, yield differences between the LEPA and spray irrigation methods were small (Schneider and Howell,

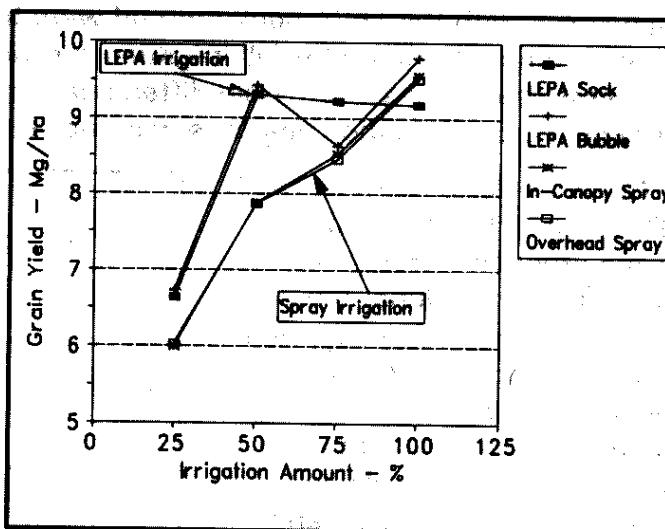


Figure 1. Grain sorghum yields in 1992.

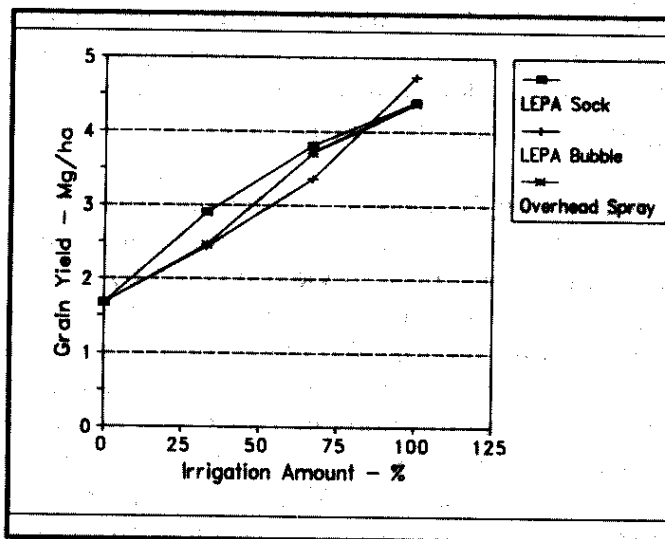


Figure 2. Wheat yields in 1994.

1994). Rainfall of 100 mm during the spring irrigation season was much below normal, and fourteen 25-mm irrigations were applied to the fully-irrigated wheat. Grain yields with the LEPA sock method were highest with the two deficit irrigation amounts, but with full irrigation the yields for all sprinkler methods were essentially the same. Yield differences among the three sprinkler methods averaged across irrigation amounts were not statistically significant ( $p=0.05$ ).

Grain yields for corn in 1994 followed a different trend than for the other two crops, Figure 3. During June, temperatures were above average, and rainfall totaled only 35 mm.

Twenty one irrigations totaling 500 mm of seasonal irrigation were applied to the fully irrigated corn. With the 25 and 50% irrigation amounts, the LEPA sock method was most efficient, but with the 75 and 100% irrigation amounts, the LEPA methods produced smaller yields than the spray methods.

With full irrigation, the average

yield of the two spray methods was 2.25 Mg/ha larger than the average yield of the two LEPA methods. When yields were averaged across irrigation amounts, yields with the LEPA bubble method were statistically smaller than for the other three methods ( $p=0.05$ ). The lower corn yields with fully-irrigated LEPA are believed to be due to irrigation runoff which occurred as the 21 seasonal irrigations eroded the furrow dikes.

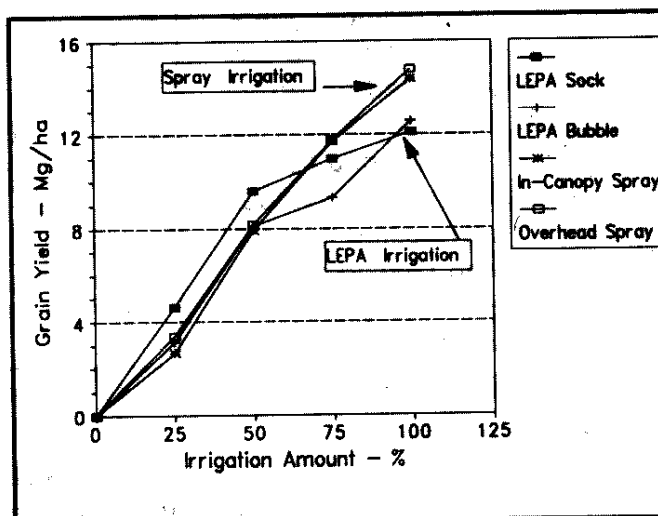


Figure 3. Corn yields in 1994.

**Water Use Efficiency.** Water use efficiency is defined as grain yield divided by seasonal evapotranspiration, and irrigation water use efficiency as irrigated yield minus non-irrigated yield divided by irrigation water applied. Water use efficiency and irrigation water use efficiency for the three crops tended to be slightly higher for the two LEPA methods, Table 1. The missing efficiency values resulted from not measuring soil water depletion for the LEPA bubble and in-canopy spray methods in 1992, and no in-canopy spray treatment for the 1994 wheat. The LEPA sock sprinkler method resulted in the highest water use efficiencies for all three crops. The lower water use efficiencies with the LEPA bubble method on corn likely resulted from increased surface redistribution and runoff due to more erosion of the furrow dikes.

### Conclusions

1. With equal deficit irrigation, grain yields with the LEPA methods tended to be larger than with the spray methods
2. With full irrigation, grain yields from the LEPA and spray methods were similar unless runoff with the LEPA method caused reduced yields.

**Table 1. Water use efficiency and irrigation water use efficiency for four sprinkler methods averaged across irrigation treatments.**

| Sprinkler Method | 1992              |                   | 1994              |                   | 1994              |                   |
|------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
|                  | Grain             | Sorghum           | Wheat             |                   | Corn              |                   |
|                  | WUE               | IWUE              | WUE               | IWUE              | WUE               | IWUE              |
|                  | kg/m <sup>3</sup> | kg/m <sup>3</sup> | kg/m <sup>3</sup> | kg/m <sup>3</sup> | kg/m <sup>3</sup> | kg/m <sup>3</sup> |
| LEPA Sock        | 1.57              | ----              | .730              | .918              | 1.11              | 2.57              |
| LEPA Bubble      | ----              | ----              | .719              | .752              | .950              | 2.15              |
| In-Canopy Spray  | ----              | ----              | ----              | ----              | 1.04              | 2.25              |
| Overhead Spray   | 1.52              | ----              | .694              | .774              | 1.10              | 2.41              |

#### Appendix. References

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